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OBSERVATIONS ON THE ECOLOGY OF THE PROTOZOA

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A GREAT deal of excellent work has been done in census taking among the Protozoa, and numerous catalogues of species with descriptions and accompanying plates have been issued for various states or portions thereof. This present communication, however, is a slight contribution toward census taking of a different sort, in that it aims to set forth some facts regarding the different types of Protozoan habitats and the species usually associated with each. It is well known that certain common forms, used as type species in the laboratory (such as *Amœba proteus* and *Paramœcium caudatum*), can be found only in certain fairly definite environments. The ecology of such forms is well known, but the bionomics of the majority of the Protozoa is still virtually a *res ignota.* The study of environmental units and Protozoan communities will contribute to a more intimate knowledge of these elusive forms.

Although little is definitely known concerning the ecology of the Protozoa, yet I think that we are in position to say that Protozoan inhabitants vary with their varying environments. A record of the inhabitants of a marsh pool will not include the same species normally found in clear running streams, nor will cold waters yield the same forms as warm. But we can go still farther, I think, and say that the various portions of any given environmental unit, even though they differ ever so slightly from one another, will each have its own characteristic group of organisms. The factors which are accountable for the variation in species or numbers of individuals of any species in such instances may be hardly discoverable, but they are none the less potent. Thus the entrance point of a tiny thread of clear spring water in the midst of an impure pool may furnish an abundance of *Monas* and *Cercomonas*, and because of the presence of these, also the larger carnivorous forms such as *Dileptus* or *Onychodromus*. Or the growth of myriads of bacteria at another point may induce the increase in the numbers of *Vorticellæ, Amœbæ*, or *Holophryæ*. A complete study of the multitudinous minute variations in the environments of Protozoa, and their complex relationships with the associated species is still far away. But I believe that we are now ready to undertake a preliminary survey of a number of typical environments and to ascertain what genera and species may be normally expected to occur in each.

Of the many factors responsible for the localization of species, the following are perhaps first in importance: light, character of food, temperature of water, chemical content of water, presence or absence of enemies.

Light exerts a powerful influence in determining the distribution of species within a given body of water. Thus one will find certain species in sunlit areas and certain others in shaded ones. Not all of the Protozoa respond to ordinary light stimuli, as has been shown experimentally by Jennings.[1] He has found that comparatively few of the ciliate infusoria react to light stimuli. The flagellates, on the other hand, show a definite reaction, congregating in that region where the light is ordinarily strongest. The reactions of *Euglena viridis* and *Cryptomonas ovata* are the forms which have been most carefully studied in this regard.

Jennings[1] further showed that *Paramœcia* collect in those regions of the water which contain a trace of any weak acid, and this I have noted to be true of certain other ciliates. This may be a dominant influence in localizing forms in pools and streams in marshes where organic acids are usually present. The presence of supernormal amounts of oxygen, carbon dioxide, calcium carbonate, iron, and other dissolved substances may also affect the distribution of species.

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[1] "Contributions to the Study of the Behavior of Lower Organisms," H. S. Jennings, Washington, 1904.

Not only may the various stimuli arising from the different elements of the environment assort species into communities, but the effects of these stimuli may not always be the same. A given stimulus may at one time produce a certain type of reaction, and at another time a somewhat different type. This fact, also, experimentally verified by Jennings, led him to suppose that something analogous to, if not identical with true varying "physiological states" obtains in the Protozoan body. If this be so then the problem of Protozoan ecology is still further complicated, as far as any assignment of species to definite fixed local environments is concerned.

For collecting Protozoa and water samples the writer has found the following useful: a small silk plankton net (with draw string bottom) about six inches in diameter and ten inches deep; a glass or metal pipette, fully a foot in length, operated by a compression bulb at one extremity, for sucking samples of light sediments from the bottoms of pools and streams; several small glass dipping tubes; a large table spoon; a thermometer, and a plentiful supply of variously sized water tight jars with screw tops. With such an outfit as this the material described in the following paper was secured. The samples were examined immediately after being brought into the laboratory, in order that the proportions of species might be accurately recorded.

From each sample ten slides were searched. The significance of the terms few, numerous, rare, etc., is as follows:

Over ten individuals of one species per slide	abundant
Average of 5–10	numerous
Average of 2–5	several
Average of .5–2	few
Average of less than .5	rare

The samples were taken from the uppermost layer of silt on the bottoms of pools, streams, etc., the utmost care being taken not to disturb the sediment below or to roil the water. Upwards of fifty samples were secured representing five distinct environmental types. These five types described are:

No. 1. Characteristic marsh pools.

No. 2. Clear cold lakes and streams with no plant life.

No. 3. Clear springs and streams with plants abundant.

No. 4. Small, clear pools containing organic sediment in decomposition and fed by pure, cold rills.

No. 5. Ditches and pools choked with algæ, water warm.

All of the material was taken during the months of late spring, summer, and early fall, while the aquatic vegetation, and the semiaquatics about the water margins, were in vigorous growth.

Environmental Type No. I: Marsh Pools

Characteristic frog-inhabited marsh pools, containing much decaying vegetable matter, supporting rank growths of typical marsh plants about the margins, covered with lily pads and filled with *Ceratophyllum, Myriophyllum, Sagittaria,* duckweed, etc. Water warm, and emitting characteristic swampy odor.

Predominant forms:

Amœba limax, several
Amœba proteus, several
Amœba radiosa, several
Arcella vulgaris, numerous
Carchesium polypinum, numerous
Codonocladium umbellatum, numerous
Coleps hirtus, abundant
Coleps sp., abundant
Difflugia acuminata, numerous
Difflugia corona, numerous
Difflugia globulosa, numerous
Euglypha alveolata, numerous
Oikomonas sp., numerous
Peridinium cinctum, abundant
Stylonychia mytilus, numerous
Stylonychia pustulata, numerous
Stentor polymorphus, numerous
Synura uvella, numerous
Trinema acinus, numerous
Vorticella microstoma, numerous
Vorticella nutans, numerous

Other forms present in less numbers (few or rare):

Actinophrys sol
Arcella dentata
Arcella discoides
Anisonema obliqua
Astasia sp.
Biomyxa vagans
Blepharisma lateritia
Centropyxis aculeata
Colpoda sp.
Cothurnia maratima
Dactylosphærium radiosum
Dinomonas vorax
Euplotes carinata
Euplotes charon
Halteria grandinella
Heterophrys myriapoda
Holophrya sp.
Lacrymaria olor
Lionotus wrzesmosky
Lionotus sp.
Loxophyllum sp.
Paramœcium bursaria
Pleuronema sp.
Prorodon griseus

Stentor cœruleus
Trichodina pediculus (on *Hydra fusca*)
Urocentrum turbo
Volvox globator
Vorticella sp.

Blepharisma lateritia (Fig. 1) is usually described as showing pink or even reddish hues, and occurring rarely colorless. My experience has been to find the greater number of individuals colorless and a very few showing even a faint trace of pink. In reproducing the colors of Protozoa in plates there seems to be a tendency to represent them more vividly than they occur in nature. It is interesting to place a small chart of spectrum colors on the table near the base of the microscope and compare them with the hues of those species of Protozoa usually represented as brightly colored. It has been my experience to find that the (depicted) decided colors of some of the Protozoa show themselves to be only the faintest tints.

Synura uvella (Fig. 2) is not entirely colonial in its habit. I have found it sometimes singly, and often in pairs. The normal number of individuals in a colony is from 10 to 20. As many as 35 in one group have been recorded. The flagella are invisible unless iodine or some good stain has been used.

The *Coleps* sp. (Fig. 3) which I found so frequently in this one group of samples I have never found since. It was appreciably smaller than *Coleps hirtus* (Fig. 4), being about 30 microns in length, whereas *hirtus* is 50. *Hirtus* is a species exhibiting a notable constancy in dimensions, and this I found true also of all the numerous individuals of *Coleps* sp. which I measured. No transitions in size from one to the other could be found. *Coleps* sp. was not the result of fission on the part of *hirtus,* for in all the material my search revealed not a single individual undergoing division. In appearance and activities the one form was the exact counterpart of the other, with a solitary exception: the movements of *Coleps* sp. were at all times much more rapid than those of *hirtus.*

Lacrymaria olor (Fig. 5) described as a very variable species, is variable in *size* almost entirely. Its *form* is quite constant, and offers a virtually certain criterion for identification.

PLATE I

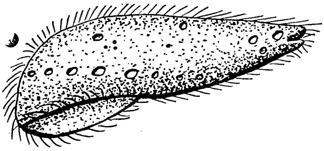


Fig.I Blepharisma lateritia

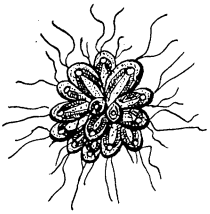
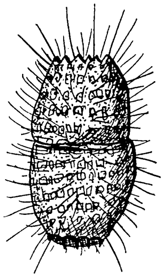


Fig.2 Synura uvella



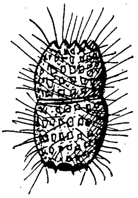


Fig.3 Coleps sp.

Fig.4 Coleps hirtus

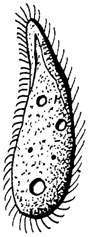


Fig.6 Loxophyllum sp.

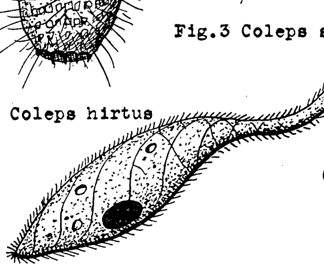


Fig.5 Lacrymaria olor

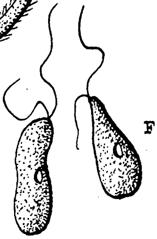
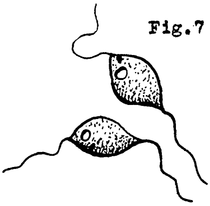


Fig.7 Astasia contorta



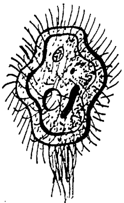
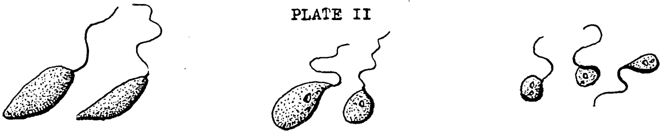


Fig.9 Cercomonas crassicauda

Fig.8 Urocentrum turbo

Fig.10 Cercomonas termo, normal and abnormal forms

PLATE II



Monas Dallingeri

Monas fluida

Monas irregularis

Fig.11

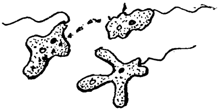


Fig.12 Mastigamoeba sp.

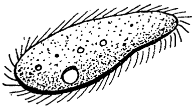


Fig.13 Enchelys sp.

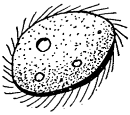


Fig.14 Holophrya sp.

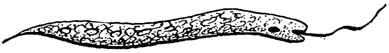


Fig.15 Euglena deses

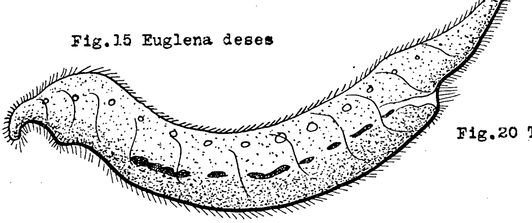


Fig.16 Dileptus gigas

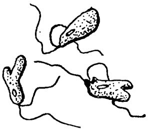


Fig.20 Trepomonas agilis

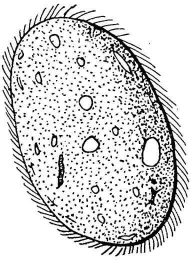


Fig.19 Frontonia sp.2

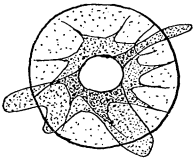


Fig.17 Arcella discoides

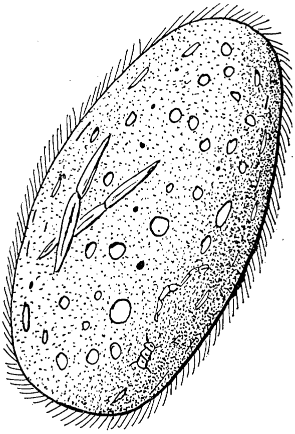


Fig.18 Frontonia sp.1

The body of *Loxophyllum* (Fig. 6) is surprisingly elastic. For this reason the creature undergoes rapid variations in length. Even within the confinement of a viscous gelatin solution which checks the motions of all of the other ciliates its strength is such as to enable it to perform various evolutions over the slide. In staining it frequently dies in a contorted and contracted condition. Before staining, it should be narcotized with a weak ethyl alcohol or killed with .01 per cent. osmic acid.

In *Astasia* (Fig. 7) the smaller secondary flagellum is sometimes either unusually filamentous, and therefore invisible, or lacking altogether. In many individuals no amount of manipulation of light directions and intensities or stains will reveal the smaller flagellum.

Urocentrum turbo (Fig. 8) can always be recognized by the frenzied and jerky rotation which accompanies its extremely rapid movement through the water. It usually comes to rest either close beside or buried among masses of algæ or other convenient material. In this resting condition it is liable to be overlooked. At such times its only evidence of activity is a scarcely perceptible twitching. This hiding in algal masses has all the appearance of being a deliberate attempt at concealment. Suddenly without warning its crazied rotation through the water is begun again. When swimming with retarded velocity through a gelatin solution, functional anterior and posterior portions of the body are recognizable.

ENVIRONMENTAL TYPE NO. II: CLEAR COLD WATERS LACKING PLANT GROWTHS

Sediment, composed of quartz and shale sands free from organic silt and supporting no plant life save a few Diatoms, in clear, pure, cold lakes and streams; temperature of water, cir. 56° F.

Predominant forms:

Astasia sp., abundant
Holophrya sp., numerous
Holostichia vernalis, numerous
Nostolenus orbicularis, several
Nostolenus sp., several

Other forms present in less numbers (few or rare):

Cercomonas termo
Cercomonas crassicauda
Chlamydomonas sp.
Colpidium sp.
Euplotes sp.
Lionotus sp.
Paramœcium bursaria
Stylonychia mytilus

The nucleus of *Cercomonas crassicauda* (Fig 9) is located near the functional anterior end of the body, and is not easily seen. The anterior flagellum is likewise difficult to distinguish, even upon staining, being exceedingly filamentous. It seems to have little to do with locomotion, and I believe that it is used principally as a sort of antenna. The propulsion of the creature is apparently accomplished by the lashings of the stout posterior flagellum, no matter which end of the organism is directed forward.

Cercomonas termo (Fig. 10), from 5 to 15 microns, is extremely variable in shape in the adult form. Its commonest and therefore characteristic appearance is roughly heart shaped, the flagellum arising from the broader extremity of the body. The young are not so variable, but although constant in general form, confusingly resemble the monads, in particular *Monas irregularis*. Their minuteness (.5 to 2 microns) makes them difficult to identify. They should be stained with a very weak solution of iodine or acetic methyl green, since the stronger stains, used for the larger Protozoa, cause them to lose their characteristic outline and to disintegrate in a short time.

Environmental Type No. III: Clear Flowing Water with Abundant Plant Life

Clear springs and streams supporting vigorous growths of such algæ as *Spirogyra, Drapernaldia,* etc., and water cresses; bottoms covered with Diatoms (often chiefly *Meridion circulare*), Desmids, and *Oscillatoria*. Temperature of water, cir. 66° F.

Predominant forms:

Amœba proteus, abundant
Amœba proteus, flagellospores (?), abundant
Chilodon cucullus, abundant
Chilomonas paramœcium, abundant
Colpidium sp., several
Colpoda inflata, several
Difflugia constricta, numerous

Difflugia globulosa, numerous
Difflugia lobostoma, numerous
Holophrya sp., several
Holostichia vernalis, several
Monas fluida, abundant
Monas irregularis, abundant
Monas Dallingeri (?), abundant
Nostolenus orbicularis, numerous
Oxytrichia pellionella, abundant
Prorodon teres, numerous

Other forms present in less numbers (few or rare):

Arcella artocrea
Aspidisca costata
Astasia contorta
Cercomonas crassicauda
Chilodon sp.
Chlamydomonas sp.
Colpidium striatum
Dileptus gigas
Enchelys sp.
Epiclintes radiosa
Euglena viridis
Euglena minima
Frontonia sp. 2
Holophrya sp.
Lionotus wrzesmosky
Mastigamœba sp.
Onychodromus grandis
Oxytrichia bifaria
Phacus sp.
Paramœcium caudatum
Stylonychia mytilus
Stylonychia pustulata

The identification of the *Monas* species (Fig. 11) is very difficult. Members of this genus resemble some of the members of the genus *Bodo*. Because of the hyaline character of the body its outline is not easy to distinguish. I have found that the most successful method of treatment before identification is attempted, is staining with a strong aqueous solution of iodine and potassium iodide. This both kills and stains. Examination must be made almost immediately since the organisms begin to lose their characteristic form in a short time.

Within the genus *Holophrya* have been provisionally placed a number of forms very closely allied in general characters. For a considerable number of these a separation into species has not yet been made.

The pseudopodia of the Mastigamœbæ (Fig. 12) do not invariably disappear with the appearance of the flagellum. They often remain, though much diminished in size, and even exhibit appreciable movement. Such movement, however, does not appear to aid in locomotion.

Enchelys (Fig. 13) is very like *Holophrya* (Fig. 14) and only under the most favorable conditions of staining and lighting can the side opening buccal orifice be definitely located. The proboscis-like projection at the anterior extremity of the body is subject to considerable modification, and can not be relied upon as a distinguishing feature, but the position of the buccal cavity is virtually constant.

Euglena deses (Fig. 15) is recognizable by its enormously elongated body, for the propulsion of which its small flagellum seems inadequate. It frequently assumes an almost amœboid form, and not infrequently contracts to such an extent as to become nearly globular. Being variable in size, its form, when swimming by means of its flagellum, offers the readiest means of identification.

One particular locality, given especial notice, deserves detailed mention. This was a spring pool in a boggy upland meadow, almost hidden among large tufted clumps of luxuriant sedge-like grasses. The depth of the pool was about four inches, and its area about six square feet. Although exposed to the rays of the sun during the greater part of the day, yet the temperature of the water was kept low by a constant trickle of cold water from seepage springs in the glacial clays which underlay several acres of the region. The iron content of the water was unusually high, though the pool was crystal clear. Of higher aquatic plants there were none; Desmids were numerous; Diatoms were sufficient in numbers to form a brown film over the entire bottom. The pool contained seven large black-nosed dace, and other adjacent pools harbored several more. Snails, *Limnea* and *Physa* crawled everywhere. With the exception of half a dozen large *Hydrophilidæ* there were no aquatic insects, and but very few *Entomostraca.*

The predominant forms were *Monas fluida* and *irregularis,* occurring not alone in the bottom film but everywhere throughout the water and in great numbers. One species of *Holophrya* and *Cercomonas crassicauda* (but few individuals of each) completed the census of the forms.

ENVIRONMENTAL TYPE NO. IV: CLEAR SMALL POOLS WITH ABUNDANT DECOMPOSING ORGANIC SEDIMENT

Small clear pools in depressions in rocks containing decaying leaf material and a small quantity of such algæ as

Spirogyra, Zygnemea, Mougeotia, etc., Desmids and Diatoms abundant. Water kept pure and cool by influx from small rills or by seepage from adjacent stream. Temperature of water, cir. 60° F.

Predominant forms:

Chilodon cucullus, numerous
Chilomonas paramœcium, abundant
Coleps hirtus, numerous
Difflugia globulosa, numerous
Holophrya sp., numerous
Holostichia vernalis, numerous
Monas sp., abundant
Paramœcium bursaria, numerous
Tracheloceerca olor, numerous
Vorticella nutans, several

Other forms present in less numbers (few or rare):

Amœba proteus
Anisonema obliqua
Arcella vulgaris
Aspidisca costata
Chilodon vorax
Chlamydomonas sp.
Colpoda cucullus
Cyphoderia ampulla
Dallasia frontinia
Difflugia acuminata
Difflugia pyriformis
Dileptus gigas
Dileptus monilatus
Euglena deses
Euglena viridis
Euglypha alveolata
Euplotes sp.
Frontonia sp.
Hyalosphenia papilio
Loxophyllum sp.
Nostolenus orbicularis
Oxytrichia bifaria
Oxytrichia pellionella
Paramœcium caudatum
Pleuronema sp.
Prorodon armatus
Stylonychia pustulata
Stylonychia putrina

Dileptus gigas (Fig. 16) is surely the king of beasts among the ciliate Protozoa. It is entirely carnivorous and its appetite is apparently insatiable. The prey is stung by the well developed trichocysts which *Dileptus* bears upon its long "neck" and if too large to be swept into the buccal cavity by the cilia is forced in by the writhings of the "neck." The creature varies greatly in size, but is normally about 450 microns in length. Individuals have been reported measuring 800 microns!

Environmental Type No. V: Pools Choked with Algæ; Water Warm

Ditches and pools choked with heavy, luxuriant masses of algæ (*Spirogyra, Ulothrix, Zygnemea*, etc.) and exposed to the sun during the entire length of the day. *Cyclops, Canthrocamptus, Gammarus, Daphnia, Cypris, Simocephalus*, etc., abundant. In lesser numbers: aquatic insects (especially the *Hydrophilidæ*), *Limnea, Physa, Planorbis,* etc. Temperature of water, cir. 70° F.

Predominant forms:

Cercomonas termo, abundant
Chlamydomonas sp., numerous
Difflugia globulosa, numerous
Euglena viridis, very abundant
Monas fluida, very abundant
Monas irregularis, very abundant
Peridinium cinctum, numerous
Synura uvella, numerous
Trepomonas agilis, very abundant

Other forms present in less numbers (few or rare):

Actinophrys sol
Arcella discoides (?).
Arcella mitrata
Arcella vulgaris
Colpoda campyla
Cyphoderia ampulla
Frontonia sp.
Vorticella nutans

The species which I identified as *Arcella discoides* (Fig. 17) was much smaller than usual. Although there is considerable variation in size among the members of *Arcella* and particularly among *Arcella discoides* and *vulgaris,* yet I have never seen recorded individuals so small. The average diameter of twenty-five individuals from one sample was 70 microns.

The *Frontonia* species (Figs. 18 and 19) are very fully equipped with trichocysts. When irritated with acetic acid and then stained with iodine or methyl green they show beautifully. For use in the laboratory in the demonstration of the trichocysts of the ciliata they offer the best possible material. The species are not very common, however, and I know of no culture medium.

Trepomonas agilis (Fig. 20) varies greatly in size. Its apparent variation in shape can be explained, I think, by the fact that it swims sometimes with one aspect of the body presented to the observer and sometimes with another. The curious irregularity of its body would therefore allow it to show a number of different outlines. Often it swims in one position for a long period, and again it twirls rapidly about going through the whole gamut of its apparent changes of form in a few seconds.

In one typical roadside ditch overhung with grasses and weeds and literally filled to overflowing with rich masses of *Spirogyra* I found an almost pure culture of *Euglena* *viridis.* The only other forms present were but very few *Colpoda campyla* and *Cyphoderia ampulla.*

Several samples were taken from leaves and grass frozen together, lying beneath three inches of solidly compacted snow in a small oak grove not far from a ravine through which flowed a perennial stream. This material was allowed to stand in its own snow in a cotton-tamponed jar until the snow had melted and the resulting water had attained room temperature, cir. 72° F.

The *Amœba proteus* were more abundant than I had ever seen them before except in artificial cultures. Not infrequently as many as ten individuals could be counted at once in the field of the 10 mm. objective. The other predominant forms were:

Holostichia vernalis, abundant.
Monas irregularis, abundant.
Opalina ranarum, several
Paramœcium caudatum, several

Other forms present in less numbers (few or rare):

Astasia lagenula
Oikomonas sp.
Paramœcium trichium
Platyrichotus opisthobolus

CATALOGUE OF SPECIES NOTED WITH MEASUREMENTS IN MICRONS

In each case *length* refers to the antero-posterior axis, except with globular or subglobular forms when it refers to the diameter of the body. All dimensions are given in microns (=1/1000 mm.).

It is interesting to recall, in connection with the sizes of these organisms, that the diameter of the average human hair is 100 microns.

Genus	Species	Length
Actinophrys	*sol*	60
Amœba	*limax*	50–60
Amœba	*proteus*	125 (variable)
Amœba	*radiosa*	50–100 (variable)
Anisonema	*obliqua*	
Arcella	*artocrea*	160
Arcella	*dentata*	95
Arcella	*discoides*	115
Arcella	*mitrata*	100–150
Arcella	*vulgaris*	55 (variable)
Aspidisca	*costata*	30

Astasia	*contorta*	30 (variable)
Astasia	*lagenula*	30
Astasia	sp.	75
Biomyxa	*vagans*	50 (variable)
Blepharisma	*lateritia*	170
Carchesium	*polypinum*	60 (bell only)
Centropyxis	*aculeata*	125–150
Cercomonas	*crassicauda*	25
Cercomonas	*termo*	5–15
Chilodon	*cucullus*	135
Chilodon	*vorax*	70
Chilodon	sp.	42
Chilomonas	*paramœcium*	40 (variable)
Chlamydomonas	sp.	17
Codonocladium	*umbellatum*	8–12
Coleps	*hirtus*	50
Coleps	sp.	30
Colpidium	*striatum*	45
Colpidium	sp.	34
Colpoda	*campyla*	70
Colpoda	*cucullus*	95
Colpoda	*inflata*	45
Colpoda	sp.	50
Cothurnia	*maratima*	85
Cyphoderia	*ampulla*	75
Dactylosphærium	*radiosum*	25 (variable, body only)
Dallasia	*frontinia*	150
Difflugia	*acuminata*	100–300
Difflugia	*constricta*	50–100
Difflugia	*corona*	150–250
Difflugia	*globulosa*	20–50
Difflugia	*lobostoma*	90–120
Difflugia	*pyriformis*	250–350
Dileptus	*gigas*	450 (variable)
Dileptus	*monilatus*	200
Dinomonas	*vorax*	18 (variable)
Enchelys	sp.	50
Epiclintes	*radiosa*	50
Euglena	*deses*	50–200
Euglena	*minima*	30 (variable)
Euglena	*viridis*	50 (variable)
Euglypha	*alveolata*	75
Euplotes	*carinata*	80
Euplotes	*charon*	90
Euplotes	sp.	35
Frontonia	sp. 1	300–450
Frontonia	sp. 2	100
Halteria	*grandinella*	25
Heterophrys	*myriapoda*	60
Holophrya	sp.	25–45

Holostichia	*vernalis*	50
Hyalosphenia	*papilio*	125
Lacrymaria	*olor*	
	extended	360
	contracted	90
Lionotus	*wrzesmosky*	225
Lionotus	sp.	30
Loxophyllum	sp.	50
Mastigamœba	sp. (*repetans?*)	20
Monas	*Dallingeri*	These vary between 1 and 5
Monas	*fluida*	
Monas	*irregularis*	
Nostolenus	*orbicularis*	35
Nostolenus	sp.	17
Oikomonas	sp.	10–20
Onychodromus	*grandis*	100–350
Opalina	*ranarum*	115
Oxytrichia	*bifaria*	100–280
Oxytrichia	*pellionella*	80–150
Paramœcium	*bursaria*	90–150
Paramœcium	*caudatum*	150–300
Paramœcium	*trichium*	85
Phacus	sp.	80
Platyrichotus	*opisthobolus*	50
Pleuronema	sp.	50
Prorodon	*armatus*	25
Prorodon	*griseus*	40
Prorodon	*teres*	150
Stentor	*cœruleus*	100–400
Stentor	*polymorphus*	100–300
Stylonychia	*mytilus*	80–150
Stylonychia	*pustulata*	80–150
Stylonychia	*putrina*	50 (variable)
Synura	*uvella*	
	individual	10
	colony	35
Trachelocerca	*olor*	70–130
Trepomonas	*agilis*	8–10
Trichodina	*pediculus*	230
Trinema	*acinus*	60
Urocentrum	*turbo*	45
Volvox	*globator*	
Vorticella	*microstoma*	45
Vorticella	*nutans*	70
Vorticella	sp.	60